Montana Value Added Safflower for Vegetable Oil-Based Lubricants (Montana State University, Eastern Agricultural Research Center, Bozeman/Sidney)

The objective of this project is to evaluate, develop and improve high oleic safflower for vegetable oil-based lubricants and hydraulic fluids. The project should help attract the agricultural-based lubricant industry to Montana. High oleic safflower has a preferred fatty acid profile for bio-lubricants. An improved oxidative stability along with an improved fatty acid profile will further strengthen a developing vegetable oil-based lubricant market for safflower. This project uses laboratory instruments and analytical chemistry to identify safflower lines with preferred fatty acid profiles and antioxidants for vegetable oil-based lubricants. The need for a high oleic feed stock oil will become ever more important. High oleic safflower oil ideally fits the requirement for vegetable oil-based lubricants. The breeding potential exists to increase safflower oleic levels and drastically improve antioxidant properties for the lubricant market.

Camelina Sativa: A Low-Input Oil Crop for Omega-3 Culinary Oil and Animal Feeds (Montana State University, Bozeman)

Camelina sativa, or camelina*,* is a crop containing valuable oil, fiber and high quality protein. This crop can be economically produced throughout Montana providing a much-needed high value crop with relatively low input costs for Montana producers. The oil content of camelina is 40-48% and contains high levels of omega-3 fatty acids. Omega-3 fatty acids are rapidly emerging as the healthy oil of the 21st Century and are beneficial in the prevention and management of many chronic diseases including cardiovascular disease and arthritis. The most common source of omega-3 fatty acids in the human diet is fish, but few Americans consume adequate quantities of this important food. MSU and the Great Northern Growers are working together to scale-up production of camelina in Montana. The seed will be cold pressed to extract the oil at Peaks and Prairies Oilseeds in Malta. The oil can be used to produce high-value culinary and cosmetic products or environmentally friendly biofuels and biolubricants. Camelina meal, the seed by-product after oil extraction, retains about 10% oil and can be formulated into omega-3 enriched animal feeds (cattle, poultry, fish and pets). The Montana Board of Research and Commercialization Technology funding will support scale up production of *Camelina sativa* in Montana and development, processing, and marketing of high omega-3 culinary oils and animal feeds.

Development of Advanced Materials for Optoelectronics and Optical Communication Technologies (Montana State University, Bozeman)

Electro-optical and nonlinear optical crystals such as lithium niobate and tantalate are important materials for light beam control with the help of an applied electric field. They are widely used in optoelectronics and optical communication. The conventional commercial congruent crystals have a large number of atomic intrinsic defects, significant microscopic disorder, and are tolerant to non-controlled impurities. Therefore, the technical scope of these materials for many applications is limited. Researchers at MSU have found an opportunity to obtain off-congruent lithium niobate crystals with a strongly reduced concentration of intrinsic defects. This can significantly improve various crystal properties. The project will be concentrated on the development of methods for obtaining advanced materials by means of comparative study of intrinsic and

extrinsic defects in these materials. Magnetic resonance spectroscopy in combination with optical methods will be used for defect characterization on the atomic level. The work will be performed in collaboration with Scientific Materials Corporation in Bozeman. The optimized materials will be suitable for various scientific and industrial applications.

Feeding Barley Beta-Glucans to Stimulate the Immune System of Calves (Montana State University, Bozeman)

This research project investigates the effect of feeding a barley-based pellet, containing high levels of beta-glucan, on immune response in cattle. Antibiotic use in food-producing animals is a concern due to the possibility of bacteria developing resistance to antimicrobial agents with similar uses in animals and humans. In addition, there are very few antimicrobial agents effective against viral infections. Therefore, the goal of the project is to investigate the possibility of stimulating the immune system of food-producing animals through non-antibiotic means, such as incorporating feeds containing compounds that stimulate the immune system. Barley contains beta-glucans, which have been reported to stimulate the mammalian immune system, and barley is an important crop and livestock feed in Montana. Preliminary research demonstrates that mice consuming high beta-glucan barley diets had increased levels of antibodies after a viral infection and improved weight gains post-infection compared to mice consuming corn-based diets. The objective of the current study is to determine the immune response and weight gain in calves fed barley with high beta-glucan content after infection with a virus. Data will be collected to evaluate their ability to mount an immune response and eliminate viral pathogens. The anticipated results of this project may contribute to improved animal health and promote an interest in discovering practical and economical alternatives to antibiotic use. This in turn could result in new markets for Montana barley.

Optical Fiber Communications Using Electro-Optic Transducers (Montana State University, Bozeman)

MSU researchers have invented and demonstrated a method of modulating light on an optical fiber by electro-mechanical means with the purpose of creating an additional information channel on the fiber. The novel aspect of the research is the creation of a communication link by modulating the perturbing signal with a data stream. The method is non-invasive and can be installed on an existing fiber optic link or network without perturbing the system and could be used in fiber optic telecommunications networks to support network operations, control and management functions. Additionally, the method could be used in sensor networks. The goal of the project is to move this communication concept, which has been successfully demonstrated in the laboratory, to a product with the cooperation of Montana-based technology partners. Researchers will develop an electro-optic modulator that offers the advantages of low complexity, ease in manufacture, low operating voltage and compact size. Significant fundamental research and engineering challenges need to be addressed at the system and device levels and will be explored with the MBRCT funding. One of the major outcomes will be the design of a novel inline device for phase modulation based on waveguide structures that will be easily installable in an optical communication system using conventional fiber optic connectors. This device will be the key component in a communication system that has

applications in telecommunications and sensor networks.

Accelerated Development of Two Gene-Imidazolinone-Tolerant Wheat Varieties for Montana (Montana State University, Bozeman)

Weed competition is a major impediment to wheat production in Montana. Herbicides provide excellent weed control for many problem weeds. However, in some cases the target weed is so closely related to the wheat crop that no selective herbicide is available. The most troublesome case in Montana is jointed goat grass, as its close relationship to wheat means that effective herbicides also cause significant crop damage. Recent research has provided the means to overcome this problem by the development of herbicide-resistant wheat varieties. In particular, resistance to the wide-spectrum imidazolinone ("imi") herbicides has been developed by mutagenesis of only two target genes. The resistance genes are native to wheat, thus the varieties are not considered to be 'GMO' nor are subjected to marketing restrictions. The project aims to develop "imi"-resistant spring and winter wheat for Montana to increase profitability by providing effective control of jointed goat grass and other problem weeds.

A New Weapon for Reducing Sawfly Damage in Montana Wheat Fields (Montana State University, Bozeman)

Recent research has shown that wheat stem sawfly females will choose to selectively lay their eggs in the stems of wheat plants that release larger amounts of certain attractive odors. This choice is made when the insects can pick one variety over another, for example, when the varieties are grown adjacent to each other. Most of the eggs are then laid in the variety releasing the higher levels of attractants. Losses due to the wheat stem sawfly are currently partially managed by planting solid-stem wheat varieties that resist lodging and kill a proportion of the immature sawflies. Even the best yielding of these solid-stem wheat varieties always yield a couple of bushels less than the very best hollow stem varieties, even considering the tremendous improvements in the yield of solid-stem spring wheat varieties in recent years. This proposal focuses on the development of highly attractive, very solid-stem spring wheat varieties to be used as management tools for reducing sawfly numbers in conjunction with unattractive, higher yielding hollow-stem spring wheat. Planting small acreages of this highly attractive, very solid-stem wheat to manage the sawflies would increase the number of acres that could be planted to the highest yielding hollow-stem varieties. A successful project could result in an increase of wheat production capability in Montana worth tens of millions of dollars.

A User Grant Program for the Montana Microfabrication Facility (Montana State University, Bozeman)

Creating and testing micro devices used to be something done only at expensive facilities located out of state, but now with the help of the Montana Board of Research and Commercialization Technology (MBRCT), Montana industry can gain access to the new Montana Microfabrication Facility (MMF), located at Montana State University in Bozeman. The MMF is a modern micro device fabrication and packaging laboratory used by academic and commercial users who need a clean environment and specialized manufacturing tools to create micro devices ranging from chemical and biological sensors to chips used in lasers and other versatile optical devices. The MBRCT award provides a commercial user grant program that spurs innovation and new product

development by covering the initial cost of MMF access. By eliminating the start-up cost barrier participating companies can obtain the experience and proof-of-principle results that are increasingly essential to attract subsequent investment funding. The Montana Microfabrication Facility is also able to help companies through the development stage and ultimately with the manufacturing of micro devices for commercial production.

Functional Analysis of Genes Controlling Malting Barley Grain Protein Concentration (Montana State University, Bozeman)

Mature cereal grains (such as those from wheat and barley) are mostly composed of starch and storage proteins. High grain protein content is a quality factor, and usually desirable. The remarkable exception to this rule is malting barley as high grain protein is associated with undesirable cloudiness (haze) in beer. It is well known that the nitrogen contained in grain storage proteins is recycled within the plants, mostly from yellowing leaves to the developing kernels. However, the biological processes controlling nitrogen recycling, and their influence on grain protein concentration, are still poorly understood. Therefore, the main scientific goal of this project is the identification and characterization of these processes. Subsequently, gained knowledge will be applicable for the development of improved barley varieties with stable, relatively low grain protein. With the operation of a new malting plant in Great Falls, the availability of such varieties will be of primary importance for Montana farmers.

Advancing Malting and Feed Quality in Barley (Montana State University, Bozeman)

Barley production is very important to Montana farmers since it can be used in both feed and malt applications and thus creates a variety of marketing opportunities. The goal of this project is to help enhance these opportunities by developing new varieties of barley that have enhanced feed and malt quality. The method used to achieve this is to select for increased levels of proteins that bind to the surface of starch. These proteins, the hordoindolines, do not affect agronomic yield or seed protein content, but when present in abundance on starch will allow several significant advantages. First, the increasing hordoindoline levels will impact malt quality by increasing malt extract and level of fine grind extract. Second, they will decrease the speed at which starch is digested by cattle leading to increased weight gains and reduced acidosis. The final significant advantage is reduced energy required for grain processing as the soft seed texture makes processing of grain more efficient. Increasing barley's value is important as barley has a unique ability to produce high quality grain under the chronic water deficits typically experienced in Montana. The research and commercialization project will result in increased feed and malt value for new barley varieties released by the MSU barley-breeding program for Montana farmers.

Commercialization of BmJ as a Broad Spectrum Microbial Plant Disease Control Agent (Montana State University, Bozeman)

Bacillus mycoides isolate J (BmJ) has been shown to be a highly effective biological control for Cercospora leaf spot of Sugarbeet and anthracnose of cucurbit crops. The estimated U.S. fungicide market for Cercospora leaf spot control in sugar beets is approximately $30 million per year. The objective of this research is to demonstrate to crop advisors and vegetable crop researchers that BmJ is effective for control of a wide

range of cucumber and melon diseases. Research demonstration projects will be conducted in Florida, Texas, California and Michigan with established private and university based researchers. The estimated U.S fungicide market for cucurbit crops is approximately $50 million per year. In addition, research/demonstration projects have been initiated on bananas with both Dole and university based researchers in Costa Rica. The bananas are the single largest fungicide market in the world (approximately $140 million per year) and BmJ has been shown to be effective in prior research. These research /demonstration projects will serve to initially place BmJ in the marketplace for these crops upon EPA approval. A second objective of this project is to research the potential for BmJ to control virus diseases of tomato and potato and Pythium root rot diseases of a range of crop and ornamental plants. If positive results are obtained in these greenhouse based research trials, this work will move to field trials. Recent research has shown that BmJ induces plant resistance by activating the NPR I gene. This gene is found in most plant genera and is the same gene activated by ActiGard (Syngenta), thus it is anticipated that BmJ will control all the same disease problems as the synthetic plant activator, ActiGard. A major advantage for BmJ is that it is not phytotoxic to plants whereas ActiGard is highly phytotoxic to many broad-leafed plants such as cucurbits, sugar beets, potatoes, etc.

Biomimetic Floating Islands that Maximize Plant and Microbial Synergistic Relationships to Revitalize Degraded Fisheries, Wildlife Habitat, and Human Waste Resources (Stewart Engineering, Bozeman)

Degraded water quality in the world's aquatic ecosystems has led to deterioration of fisheries, wildlife habitats, and human water resources. As a result, governments worldwide are creating programs to clean our water, rebuild our waterways, and restore our wetlands. Floating Island International, LLC, has designed and brought to market the BioHaven^{TM} Wild Floating Island. While these islands are initially being marketed as aesthetically beautiful, enhancing biodiversity, and nurturing fish and wildlife, there is considerable anecdotal data leading to more scientific applications of these islands to naturally clean and oxygenate the waterways in which they are placed. The ability to demonstrate with quantitative data that the islands provide a highly effective, long-term, affordable alternative to existing competitive products, will establish the islands in the water-treatment marketplace.

Research and Development of a Hydraulic Fluid from Montana Grown Oil Seed Crops (Sustainable Systems, Missoula)

Sustainable Systems, LLC has developed a proprietary hydraulic fluid based on high quality vegetable oils that can be grown in Montana. Hydraulic fluids are used in a wide variety of applications most notably to activate motion on heavy equipment such as raising and lowering a scraping blade or bucket on a front-end loader. Traditionally these fluids are petroleum based; however, tighter environmental regulations and higher prices for crude petroleum have opened new markets for biobased hydraulic fluids. Approximately 180,000,000 gallons of hydraulic fluid are used each year with an estimate of 60% of this volume being transitioned to biobased fluids. Preliminary tests conducted at independent testing centers suggest that Sustainable System's hydraulic fluid meets and exceeds original equipment manufacturer (OEM) hydraulic fluid specifications. The goal of the project is to scale up processing capabilities to produce

volumes for field-testing with OEMs and Federal agencies in anticipation of commercial scale volumes being produced for use by the private sector and the federal government.

Commercialization of Miniature Lasers: Evolving from Research and Development to Production (AdvR, Inc., Bozeman)

AdvR will strive to produce lasers for a variety of commercial markets based on AdvR's core technology, the electro-optic material potassium titanyl phosphate (KTP). AdvR has successfully produced different types of research grade lasers and will use these field-tested models as the starting point for a commercial product. The produced laser system will be small, robust, and lightweight and will readily lend itself to stringent qualifications such as minimal power consumption and a small footprint. The challenge in the production of the laser is the installation, alignment, and adhesion of the KTP laser and optics into a package that meets the rigorous standards required for turnkey operation. The markets identified for these lasers include seed lasers for high power laser systems, low noise lasers for fiber optic-based sensors, and customer specific lasers for communications and spectroscopy. AdvR will use the Montana Board of Research and Commercialization Technology funding in conjunction with funding from a NASA SBIR Phase II and a NASA STTR Phase II grant to meet this goal.

Intellectual Property Development of Spatial Spectral (S2) Material Based Sensor Technologies (Montana State University, Bozeman)

Spatial-Spectral (S2) sensor materials are optical materials that can process ultra high-speed information at rates unreachable by electronics. Application of S2 technologies can revolutionize the information processing operations of radars, laser radars, and spectral analysis systems. S2 technology, along with several associated enabling technologies, are Montana grown technologies, developed by Montana State University (MSU) and Montana companies. MSU is in the process of transferring its S2-related technologies to a Montana company, which has recently received over $6 million in funding to develop S2 radar. In order to secure protection of key S2-related intellectual properties developed at MSU, the MBRCT grant and matching funds will fund continued S2 research and the preparation and filing of patent applications.

Innovative Manufacturing Techniques for Polysaccharide-Protein Conjugate Vaccines (EndoBiologics Incorporated, Missoula)

The grant from the Montana Board of Research and Commercialization Technology (MBRCT) to EndoBiologics, Incorporated provides funds to supplement a Phase II SBIR grant awarded to EndoBiologics by the U.S. Army Medical Research and Material Command. The overall goal of the Phase II SBIR project is to develop a new conjugate vaccine against dysentery caused by *Shigella* bacteria. The goal for the MRBCT grant is to test the new *Shigella* vaccine in a preclinical animal model. These studies will be performed in collaboration with scientists at the Walter Reed Army Institute of Research, and will provide key information for designing clinical trials for testing the vaccine in humans. Worldwide, there are 165 million new cases of shigellosis each year, causing over one million deaths. A new vaccine seems to be the best strategy for controlling shigellosis because antibiotic therapy provides only transitory benefits, and most pathogenic strains of *Shigella* have acquired resistance against antibiotics. The World Health Organization has selected development of a shigellosis vaccine as one of its

highest priorities, and it has formed alliances with public and private entities to fund development and distribution of this vaccine. Shigellosis is also a serious health risk for U.S. military personnel deployed in regions where the disease is endemic, as well as to travelers who visit endemic areas. EndoBiologics expects that its innovative technology for manufacturing a *Shigella* vaccine will give the company a competitive advantage, and the company intends to form strategic partnerships with other vaccine companies to enhance worldwide commercialization of its new vaccine.

Discovering Anti-TSE Agents (BioPred-Computational Bioactivity Prediction Company, Bozeman)

The Computational Bioactivity Prediction Company, BioPred LLC, is developing prototype computational software models to discover and accelerate commercialization of new pharmaceuticals. This software applies mathematical representations of chemical structure and bioactivity within advanced machine-learning (artificial neural network) systems as a paradigm shift in computational chemistry applications. Previous research and development has achieved very high correlations with pharmaceutical laboratory tests used to identify new agents for use against Mad Cow and Chronic Wasting Diseases that can fatally infect humans and pose risk to the beef industry. Development of a diagnostic test agent for live cattle represents an $11 billion market in the U.S. alone and will aid certification of disease free animals to protect local industry and exports. Prior BioPred research was in part funded by the Center for Structural and Functional Neuroscience at The University of Montana. The project will also involve collaborations with scientists at Rocky Mountain Laboratory, a NIH research facility in Hamilton.

Noninvasive Diagnosis and Treatment of Lung Cancer Using Two-Photon Photodynamic Therapy (MPA Technologies, Inc., Bozeman)

At the current time there are 40-50 million people in the United States who smoke tobacco and use tobacco orally. In 2001 it was estimated that more than 160,000 new cases of lung cancer were developing each year, and these cases will eventually be responsible for more than 150,000 deaths. More people die of lung cancer than the next five most common malignancies combined (including breast, prostate and colon). Lung cancer is the single largest killer in the world of all types of cancer. Additionally, more women die from lung cancer than from breast cancer. Unfortunately, little progress has been made in the early diagnosis of lung cancer that might lead to longer survival rates. MPA Technologies is an early-stage bio-pharma research and development company in Bozeman. MPAT has developed proprietary photodynamic therapeutic agents that can carry out noninvasive diagnosis and treatment of cancerous tumors including targeting tumor receptor sites, imaging the tumor, using digitized 3D tumor image to control laser irradiation, and activating the therapeutic agent, which can kill the tumor directly through the skin in a non-surgical outpatient procedure. This project will carry the research through pre-clinical small animal model studies and potential application for New Drug status for Phase I human trials in as little as two to three years.

Development of a Novel Tissue Valve for Surgical Replacement of Diseased Aortic and Pulmonary Valves (International Heart Institute of Montana, Missoula)

Currently, when a diseased heart valve must be replaced there are three choices, 1) a mechanical valve, 2) a bioprosthetic valve made from a pig valve or from the tissue

surrounding a cow's heart, and, 3) a homograft, a valve taken from a deceased human donor. The overall goal of this project is to test a specialized tissue treatment process that will allow donor homograft valves to be preserved in a completely different way. The disadvantages of donor homografts are they cannot be sterilized and must be stored in a frozen state, which limits the shelf life. The treatment process developed by the International Heart Institute of Montana Foundation would allow the homografts to be sterilized and stored at room temperature. The grant will allow the IHIMF to complete animal tests that are required by the Food and Drug Administration before human testing can be conducted. When the animal tests are completed the process to treat homograft valves will be offered to the medical device industry for licensing and/or will be manufactured in Montana.

Technology to Complete Program for Market Launch of Innovative Native Seed Harvester (Arbuckle Ranch, Inc., Billings)

Every year, millions of acres in the U.S. are disturbed by wildfire, highway construction, mining and overgrazing, or are converted from cropland back to a natural state. Natural grass seed species for these projects can be scarce and difficult to harvest, leading to short supplies and high costs. The Arbuckle Ranch is developing a specialized harvester for difficult-to-harvest seed. The Arbuckle Native Seedster uses counter-rotating brushes and combs to pluck and accumulate native seeds with relatively little chaff and other impurities. Under MBRCT funding, high-speed video will be used to observe and record seed dislodgement and conveyance; and a taxonomic key will be developed to describe in detail the seed morphology of economically important and difficult-to-harvest grass species in Montana and the rest of the U.S. This research will facilitate the ability to maximize Seedster operational parameters for optimal harvests of grass varieties while limiting damage or loss of valuable seed. The adaptability and simplicity of the Seedster design makes it appropriate to harvest a wide range of native species worldwide.

Development of Fluorescent Detection Technology for Proteomics (Zdye, LLC, Bozeman/Gallatin Gateway)

A Bozeman company, Zdye, LLC is developing a family of unique, multicolor fluorescent dyes (Zdyes) with properties optimized for protein detection in Proteomics. The principal use of the dyes is to find protein differences in complex protein mixtures. These differences reveal biological mechanisms that lead to drug discovery or research and the design of new diagnostics in both biomedical and agricultural fields. Professors Edward Dratz and Paul Grieco have invented the Zdyes at Montana State University. Zdye, LLC has been established to license, develop and market Zdye products for proteomics and diagnostic applications. Zdye CEO, Donald Thorne, has both a scientific and a business background and will be responsible for commercializing the new dye technology. This project will also support the development of new fluorescence measuring instrumentation by Resonon Inc., a Bozeman company. The new Resonon instrumentation promises to enhance the power of the Zdye technology by expanding the maximum information content that can be obtained with the new fluorescent dyes and to provide an additional sensitivity enhancement of approximately ten fold. In addition to the MBCRT award, Zdye, LLC has recently been awarded a two-year National Institutes of Health grant for further development of this innovative dye technology. These grants will expand the capabilities of Zdye to create a foundation for the development of a

Montana presence in the new Proteomic Technology field, which is also an important research focus at Montana State University.

Developing and Testing of a Metallic Filter to Remove Mercury from Gas Streams (Montana Tech, Butte)

The focus of this project is to further develop and test a metallic filter to remove mercury vapor in gas streams such as coal-fired power plants, municipal and hazardous waste incinerators, and other industrial plumes. This filtering system has been developed and tested based on initial funding from the U.S. Department of Energy. The initial tests were conducted in collaboration with PPL Montana in a coal fired power plant stack at Colstrip. The results indicate that the filter removes over 90% of the mercury vapor from the gas stream. MBRCT funding will help to build a larger scale filter that will simulate actual field conditions. The market for these types of devices is significant due to new regulations on mercury emissions and the numerous sources to be controlled across the United States and elsewhere.

Development of Disposable and Reusable Acoustic Bioreactors (Resodyn Corporation, Butte)

Resodyn Corporation has developed a variety of advanced mixing methods that use low frequency sound energy to solve mixing problems for solids, liquids, and gasses. Resodyn has proposed to use one of these mixing methods to greatly improve the performance of cell culture bioreactors, which are important tools in the pharmaceutical industry used to produce some of the most effective and also costly new therapeutic drugs. Improved performance of these bioreactors has the potential to lead to both faster development times for new drugs and lower production costs. The discovery and production of biopharmaceuticals is currently one of the fastest growing and most viable sectors of the U.S. economy. Research funds provided by the MBRCT will enable Resodyn to translate its breakthroughs in mixing technology into a viable commercial product that can participate in this important and rapidly expanding market.